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STRENGTH OF WELDED JOINTS MADE OF AW-5754 ALLOY UNDER STATIC LOAD CONDITIONS

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INTRODUCTION

The basic and most commonly used method of aluminum welding is gas arc welding using a fusible electrode (MIG method) and a non-fusible electrode (TIG method). This method is based on the use of alternating current with a sinusoidal waveform and a frequency of the supply voltage 50/60 Hz. During one half-period, when the electrode is an anode and the cathode becomes a welded material, the phenomenon of "cathodic cleaning" can be observed in the joint zone. During the second half-period, when the electrode is a cathode, it is cooled and intensively heated the weld pool, which contributes to the melting of the material. To ensure the arc re-ignition in the half-periods, high-frequency current arcs and voltages of 9000-15000 V are used. Due to these pulses, the ionization of the space in which the arc is ignited takes place, which makes it possible to re-ignite the arc with a slight delay.

The main problem during welding turns out to be the need to remove the aluminum oxide film. Welding problems can be caused by a large difference in the melting temperature of Al and Al_2O_3 (660 and 2060°C respectively) and a higher specific gravity of aluminum oxide (4 g/cm^3) than liquid aluminum (2,4 g/cm^3). As a result, Al_2O_3 particles fall to the bottom of the weld, being the porosity cause. The high hydrogen solubility in liquid aluminum and the practical solubility lack in the solid state can be formed in the presence of gas bubbles in welded joints.

The aim of the paper is to present the mechanical properties test results of welded joints of EN AW-5754 alloy by selected welding methods.

GEOMETRIC FEATURES OF THE SAMPLES

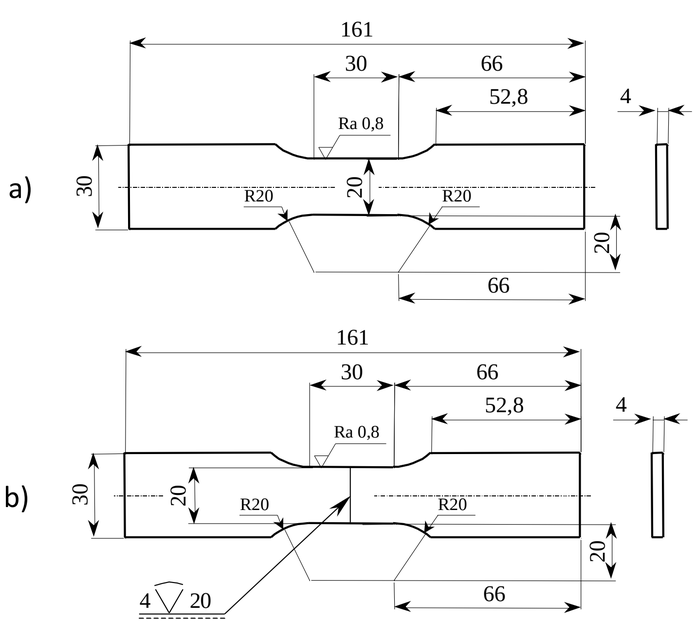

Fig. 1. Geometric features of the sample for testing under static loads: a - AW-5754 aluminum alloy sheets, b - AW-5754 aluminum alloy welded sheets

The welding process of sheets from which samples were made was carried out by the following methods:

a) welding option A – method 131 mechanized:
- voltage U = 25 V,
- current intensity I = 160 A,
- linear welding speed v = 400 mm/min,
- coefficient k = 0.8,
- linear welding energy Q = 1280 kJ/mm,

b) welding option B – method 131 semi-automatic:
- voltage U = 13.5 V,
- current intensity I = 140 A,
- linear welding speed v = 62 mm/min,
- coefficient k = 0.6,
- linear welding energy Q = 70.3 kJ/mm.

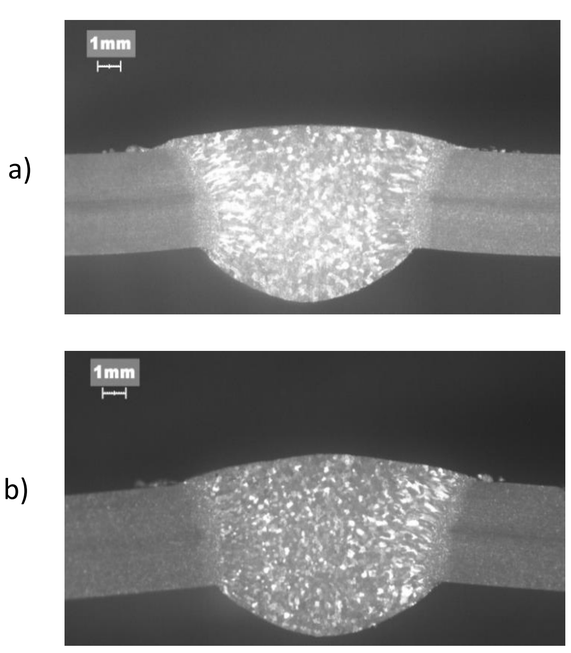

Fig. 2. Macrostructure of the welded joint from EN AW-5754 sheet metal made by the method: a - 131 mechanized, b - 131 semi-automatic.

TEST RESULTS UNDER STATIC LOADS CONDITIONS

The tests were carried out on the Instron 8502 testing machine. Sheet strength was determined on samples cut along the rolling direction and transverse to the rolling direction. The results of the tests are presented in Table 1. The tests results of the welded joints are presented in Table 2.

Table. 1. Mechanical properties of AW-5754 alloy sheet.

Sheet metal rolling direction	Statistical parameter	Mechanical properties			
		$S_{y0.2}$, MPa	S_u, MPa	E, MPa	A, %
Longitudinal	Average value	150.4	310.5	71 896	25.6
	Standard deviation	2.4	7.1	554	3.5
Transverse	Average value	111.9	218.3	68104	27.2
	Standard deviation	2.3	1.4	274	1.8

Table. 2. Mechanical properties of welded joints made by specific methods.

Welding method	Statistical parameter	Mechanical properties		
		$S_{y0.2}$, MPa	S_u, MPa	A, %
Method 131 mechanized	Average value	137.0	310.4	12.9
	Standard deviation	8.7	3.2	0.9
Method 131 semi-automatic	Average value	139.6	314.5	19.1
	Standard deviation	0.9	0.2	0.6

ANALYSIS OF TESTS RESULTS AND CONCLUSIONS

Based on the results of the research, it was found that:

a) the adopted welding energy has an effect on changing the mechanical properties of welding joints made using the 131 method,
b) there was a decrease in the yield strength Sy0.2 welded joints in relation to the parent material (Sy0.2 = 150.4 MPa) by: about 9.0% for method 131 mechanized, about 7.8% for method 131 semi-automatic,
c) the plasticity of the material decreased, which is manifested in a change in the value of welded joint samples elongation A in relation to the parent material (A = 25.6%) by: about 49.6% for method 131 mechanized, about 25.4% for method 131 semi-automatic,
d) a change in the mechanical properties of welded joints, resulting from a change in process parameters, affects the performance of strength and durability structural elements calculations.